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SCIENTIFIC INSTRUMENTATION: IT'S OLDER THAN YOU THINK

If you accidentally walked into the wrong room at a university and found yourself surrounded by balances, glass tubing, bunsen burners, flasks, beakers and the like, you could safely assume that you had entered a chemistry laboratory. Had the room been filled with timers, force tables, pulleys, oscilloscopes and the like, it might be a physics lab. The tools and instruments a scientist uses betray not only his profession but often his current line of research and the questions he is asking.

In the space below a major scientific instrument is described. Read the list slowly and try to identify the instrument. (You don't need to be a scientist to guess the answer—some of you social scientists might even have an edge.)

List of attributes:

Built to exacting measurements—some measurements accurate to within 1/1000 of an inch; diamond saws and drills used in much of the construction.

Can be used to measure the circumference of the earth within inches.

Can be used to compute the size of the earth's orbit and the acceleration of gravity.

Is so perfectly aligned to the four cardinal points of the compass that modern compasses can be calibrated from it.

Gives the length of the year:

Solar year—
obtained by observing the exact time between two successive vernal or autumnal equinoxes when day is exactly the same length as night (356 days, 5 hours, 8 minutes and 49.7 seconds);

Sidereal year—
time it takes for the same star to appear in the same spot in the sky. Is about 20 minutes longer than the solar year. This 20-minute lag is known as the procession of the equinoxes, which come 20 minutes later each year in relation to stars behind the equinoctial point;

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Anomalistic year—
orbital year in the time it takes the earth to return to the point in the elliptical orbit nearest the sun. About 4¾ minutes longer than the sidereal year.

Keeps a constant 68° temperature in the interior.
Relationship of height to base incorporates the value of Pi to 3.14159+.

(Has anyone guessed yet? Let's look at some more clues.)
Cost to duplicate this instrument would be about $1,130,390,000.
Location is at 29° 58′ 51″ North latitude.
Height is exactly 1/600 of a geographical degree and base perimeter is exactly ½ minute of longitude.
Instrument must sit on perfectly level ground—is on a seven-acre platform that is level to 1/50 of an inch.
Contains passageways which deviate from perfectly straight lines by only 1/50 inch over 150 feet.
It uses no mechanical tool or electrical power.
Built entirely of manual labor and over 40 stories tall.

(Most of you should have guessed by now.)
Built of over 2½ million limestone and granite blocks weighing two to 70 tons each.
Sides were made of polished limestone and angled inward at 51° 51′.
It is located in Egypt and was built about 3400 B.C.

(Answer—the Great Pyramid of Cheops.)

Does the answer surprise you? Most of us have been taught that the pyramid was merely the burial chamber of the pharoahs. Actually, there is no evidence whatsoever that the Pyramid of Cheops was ever used as a funerary edifice. Only the presence of an empty granite "sarcophagus" suggested such a role. Now, it is believed that the "sarcophagus" was a repository for the standardized sets of weights and measures used by the Egyptian scientists. Certainly the constant temperature prevented distortions due to thermal changes. The natural ventilation system which maintains this was so well designed that it took hundreds of years to discover, and the principles of how it works are still not understood.

Research which has continued for hundreds of years substantiates the theory that the Great Pyramid was a gigantic scientific instrument constructed to make infinitely precise measurements of the earth and

the heavens. The Egyptian units of measurements (like the metric system) were based on "natural units" found in the geometry of the earth itself. The units for length were based on divisions of the polar diameter of the earth (they were aware that the equatorial diameter was larger). The origin of the British "acre" was unknown until it was realized that it corresponded to the area the Egyptians had determined as virtually equal to a hypothetical geodetic area defined as one myriad millionth of the square on the terrestrial radius.

The Great Pyramid is overwhelming not only in its stupendous size, but also in the tremendous accuracy of the measurements incorporated into it by a primitive technology. With crude tools, a 35-acre platform was leveled to within ½ inch and the central seven acres leveled to within 1/50 inch. The huge blocks were so precisely fitted that a piece of paper could not be slipped between them. It was located slightly off of 30° North latitude to prevent distortions in observation due to the index of refraction of the atmosphere. Although the sides appear flat, they are, in fact, slightly concave to make possible more accurate measurements. At the bottom of long passageways, blocks were fitted to 1/1000 of an inch to allow reflecting pools of water or mercury to stand. Light coming from stars centered in the middle of the passageways and reflected off the pools, allowed precise alignment of the pyramid with respect to the heavens. In the many years it took for the construction, the earth wobbled on its axis and these pools allowed the pyramid to be realigned and "recalibrated."

As remarkable as the pyramid is, it would be foolish to think of it existing in a vacuum. It is only a part of a pattern of Egyptian technology and structures which extended even into Scandinavia. As one proceeds to higher latitudes, much smaller structures than the Great Pyramid still provide very accurate astronomical measurements. Large mounds topped with an obelisk or a "maypole" could substitute nicely for a Great Pyramid. In Egypt itself, the Great Pyramid when used in conjunction with other smaller pyramids found all over Egypt served as a theodolite for easy surveying of the entire nation.

If there is a lesson to be learned from our new understanding of the Great Pyramid, perhaps it is the realization of the need to reevaluate ancient structures not as instruments of religious or social design but as scientific instruments which reflect the brilliance of "primitive" man.